STAFF REPORT – DRAFT

PROPOSED AMENDMENT OF THE WATER QUALITY CONTROL PLAN – LOS ANGELES REGION – TO REVISE AMMONIA OBJECTIVES FOR INLAND SURFACE WATERS

FEBRUARY 5, 2002

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I. INTRODUCTION

Background

Ammonia is a pollutant routinely found in the wastewater effluent of Publicly Owned Treatment Works (POTWs), in landfill-leachate, as well as in run-off from agricultural fields where commercial fertilizers and animal manure are applied.

Because ammonia has a known toxic effect to aquatic life, the United States Environmental Protection Agency (U.S. EPA) Office of Water has found that the control of ammonia discharges is necessary to protect aquatic life uses in surface waters of the United States.

Ammonia exists in two forms – un-ionized ammonia (NH3) and the ammonium ion (NH4+). Both forms are toxic but the un-ionized form (NH3) is much more toxic. Un-ionized ammonia is much more toxic because it is a neutral molecule and able to diffuse across the epithelial membranes of aquatic organisms much more readily than the charged ammonium ion.

The form of ammonia is pH and temperature dependent. Low pH and low temperature leads to lower NH3 and lower toxicity.[1]

[1] The two forms are in equilibrium according to the following equation:

$$NH_4^+ \leftrightarrow NH_3 + H^+$$

$$K = \frac{[NH_3][H^+]}{[NH_4^+]}$$

The equilibrium constant K depends significantly on temperature; this relationship has been described by Emerson et al. (1975) with the following equation:

$$pK = 0.09018 + \frac{2729.92}{273.2 + T}$$

where $pK = -\log_{10}K$ and T is temperature in degrees Celsius

The following expressions can be derived for the fraction of total ammonia in each of the two forms:

$$f_{NH3} = \frac{1}{1 + 10^{pK-pH}}$$

$$f_{NH4+} = \frac{1}{1 + 10^{pH-pK}}$$

$$f_{NH3} + f_{NH4+} = 1$$

Proposed Action

The California Regional Water Quality Control Board, Los Angeles Region (Regional Board) has adopted a Water Quality Control Plan for the Los Angeles Region (Basin Plan). The existing Basin Plan establishes water quality objectives for ammonia in inland surface waters that are based on U.S. EPA guidance, data and water quality models available in 1994.

The Regional Board staff proposes an amendment to the Basin Plan to update the inland surface water (including enclosed bays, estuaries and wetlands) quality objectives for ammonia. The proposed amendment would update the current objectives outlined in the Basin Plan for all inland surface waters whose existing beneficial uses include those to protect aquatic life. The goal of this amendment is to reflect the revised criteria developed by U.S. EPA, in the "1999 Update of Ambient Water Quality Criteria for Ammonia," December 1999. The 1999 Update contains U.S. EPA's most recent freshwater aquatic life criteria for ammonia and supersedes all previous freshwater aquatic life criteria for ammonia. The proposed amendment does not alter the current ammonia objectives for saltwater outlined in the California Ocean Plan (SWRCB, 1997). The proposed amendment also includes language for implementing the revised objectives in the Los Angeles Region.

II. RATIONALE FOR BASIN PLAN AMENDMENT

U.S. EPA's 1999 Update criteria constitute the agency's current recommended federal Clean Water Act (CWA) section 304(a) criteria for ammonia, which States, Territories, and authorized Tribes may use as guidance in adopting water quality standards. Water quality standards developed from the section 304(a) criteria are designed to protect the beneficial uses identified for a particular water body. The water quality standards form the basis for establishing enforceable water quality-based effluent limitations in discharge permits.

Section 304(a)(1) of the Clean Water Act (33 U.S.C. 1314(a)(1)) directs U.S. EPA to publish and periodically update ambient water quality criteria. These criteria are to reflect the latest scientific knowledge on the identifiable effects of the pollutants on public health and welfare, aquatic life, and recreation. These criteria serve as guidance to States, Territories and authorized Tribes in adopting water quality standards under section 303(c) of the CWA that protect aquatic life from acute and chronic effects of ammonia. State and Tribal decision-makers retain the discretion to adopt water quality standards on a case-by-case basis that differ from this guidance when appropriate and where supported by local data.

In May of 2001 the Regional Board identified updating the ammonia objective as the second highest priority in its triennial review of the Basin Plan. In the very near term, and in subsequent years, the Regional Board will consider several total maximum daily loads (TMDLs) for nutrients, including ammonia. Adoption of this Basin Plan amendment will update the Region's Ammonia Water Quality Objectives, which serves as a basis for numeric targets in TMDLs and effluent limits in discharge permits. If the Regional Board does not address the 1999 Update for Ammonia, U.S. EPA will establish criteria for the Los Angeles Region by 2004.

III. PROPOSED CHANGES

Existing Ammonia Water Quality Objectives

The Basin Plan objectives for ammonia currently are based on U.S. EPA's "Ambient Water Quality Criteria for Ammonia – 1984," which contains criteria for protection of freshwater aquatic life. In 1992 U.S. EPA revised its recommended values for the Criteria Continuous Concentration (CCC) through a memorandum entitled "Revised Tables for * * * Freshwater Ammonia Concentrations." The chronic criteria were raised slightly because one of the chronic toxicity tests involving white sucker used in the 1984 criteria was no longer considered valid.

The Basin Plan currently addresses ammonia in the following manner:

> The neutral, un-ionized ammonia species (NH_3) is highly toxic to fish and other aquatic life. The ratio of toxic NH_3 to total ammonia ($NH_4^+ + NH_3$) is primarily a function of pH, but is also affected by temperature and other factors. Additional impacts can occur as the oxidation of ammonia lowers the dissolved oxygen content of the water, further stressing aquatic organisms. Ammonia also combines with chlorine (often both are present) to form chloramines – persistent toxic compounds that extend the effects of ammonia and chlorine downstream.
>
> Oxidation of ammonia to nitrate may lead to groundwater impacts in the area of recharge.
>
> *In order to protect aquatic life, ammonia concentrations in receiving waters shall not exceed the values listed for the corresponding in-stream conditions in Tables 3-1 to 3-4 [of the Basin Plan].*
>
> *Timing of compliance with this objective will be determined on a case-by-case basis. Dischargers will have up to 8 years following the adoption of this plan by the Regional Board to (i) make the necessary adjustments/improvements to meet these objectives or (ii) to conduct studies leading to an approved site-specific objective for ammonia. If it is determined that there is an immediate threat or impairment of beneficial uses due to ammonia, the objectives in Tables 3-1 and 3-4 shall apply.*
>
> *In order to protect underlying groundwater basins, ammonia shall not be present at levels that when oxidized to nitrate, pose a threat to groundwater.*

Tables 3-1 to 3-4 from the Basin Plan are reproduced in Appendix A.

Proposed Objectives

The new criteria reflect research and data analyzed since 1985, and represent a revision of several elements in the 1984 guidance, including the relationship between ammonia toxicity, pH and temperature, and the recognition of increased sensitivity of early life stage forms of fish to ammonia toxicity. The 1984 criteria were based on un-ionized ammonia (NH_3), while the 1999 criteria are expressed only as total (un-ionized plus ionized or $NH_3 + NH_4^+$) ammonia. The criteria apply to freshwater and do not impact the Ammonia Water Quality Objectives contained in the California Ocean Plan.

Chronic values presented in the updated criteria guidance were derived based on regression analysis. In the past, hypothesis testing was used whereby the chronic value was derived by calculating the geometric mean of the "no observed effects concentration" (NOEC) and the "lowest observed effects concentration" (LOEC). Regression analysis is the preferred method because it is more reflective of the magnitude of the toxic response. The results of hypothesis testing vary depend on the values tested and the variability of the database.

The most significant differences in the 1999 U.S. EPA guidance for ammonia are:

1. Acute criteria are no longer temperature-dependent but remain dependent on pH and fish species present.
2. A greater recognition of the temperature dependence of the chronic criteria, especially at low temperatures.
3. An Early Life Stage (ELS) chronic criteria was introduced.
4. Chronic criteria are no longer dependent on the presence or absence of specified fish species, but remain dependent on pH and temperature.
5. A 30-day averaging period for the ammonia chronic criteria replaced the 4-day averaging period.

Under the 1984 guidance, the acute criteria were dependent on pH, temperature, and the presence or absence of salmonids. Under the updated guidance, the acute criteria are dependent on pH and fish species, but not temperature.

The 1984 chronic criteria were dependent mainly on pH and there was no temperature dependency below 20 degrees. The updated chronic criteria are dependent on pH and temperature. At lower temperatures, the chronic criteria also are dependent on the presence or absence of early life stages of fish (ELS), regardless of species. Another significant revision in the 1999 Update is U.S. EPA's recommendation of 30 days as the averaging period for the chronic criteria instead of 4 days. The averaging period has been extended because the most sensitive test species used, *Hyallela azteca* (a freshwater amphipod) and *Muscullum transversum* (a fingernail clam) show their sensitivity after long periods of exposure.

Calculation of Proposed Objectives

1. The one-hour average concentration of total ammonia as nitrogen (in mg N/L) shall not exceed (more than once every three years on average[2]) the criteria maximum concentration (CMC) (acute criterion) calculated using the following equations.[3]

Where salmonid fish are present:

$$CMC = \frac{0.275}{1+10^{7.204-pH}} + \frac{39.0}{1+10^{pH-7.204}}$$

Or where salmonid fish are not present:

$$CMC = \frac{0.411}{1+10^{7.204-pH}} + \frac{58.4}{1+10^{pH-7.204}}$$

[2] Examining the time period for which there is data, not more than one, one-hour average value shall exceed the criterion per three years of data.

[3] U.S. EPA has not provided official guidance on what level to set the pH in these equations.

2. The thirty-day average concentration of total ammonia as nitrogen (in mg N/L) shall not exceed (more than once every three years on the average[4]) the criteria continuous concentration (CCC) (chronic criteria) calculated using the following equations.

Where early life stage fish are present:

$$CCC = \left(\frac{0.0577}{1+ 10^{7.688-pH}} + \frac{2.487}{1+ 10^{pH-7.688}} \right) * MIN\ (2.85, 1.45 * 10^{0.028*(25-T)})$$

Where T = temperature expressed in ºC.

Or where early life stage fish are not present:

$$CCC = \left(\frac{0.0577}{1+ 10^{7.688-pH}} + \frac{2.487}{1+ 10^{pH-7.688}} \right) * 1.45 * 10^{0.028*(25-MAX(T,7))}$$

Where T = temperature expressed in ºC.

3. In addition, the highest four-day average within the 30-day period shall not exceed 2.5 times the CCC.

The 1999 Criteria can be seen in three tables in Appendix 2.

IV. COMPARISON OF CURRENT BASIN PLAN OBJECTIVES AND 1999 UPDATE RECOMMENDED CRITERIA FOR AMMONIA

Criteria Maximum Concentration (acute criteria)
The CMC (criteria maximum concentration) is a function of pH and the presence/absence of salmonids. The CMC is not a function of temperature. The criteria are designed to protect the most sensitive taxa; in the case of acute ammonia toxicity, fish are more sensitive than invertebrates. During acute ammonia toxicity testing, fish survival was not seen to be dependent on temperature. Therefore, the acute criteria are not temperature dependent. Different CMC values are derived for waters where salmonids[5] are present versus not present.

For the salmonids present, acute criteria, the 1999 U.S. EPA recommended ammonia criteria are higher (less stringent) than the current Basin Plan criteria for cold water, except in the pH range of 7.25-8.25 where the temperature is between 0 and 15 degrees Celsius (32 to 59 degrees Fahrenheit) (See Figure 1). The maximum difference between the current Basin Plan objectives and U.S. EPA recommended criteria is approximately 21 mg/L as nitrogen (mg N/L) for the salmonids present, acute condition. This difference occurs at 30 degrees Celsius and a pH value of 6.5 (See Table 1a). The minimum difference between the current Basin Plan objectives and U.S. EPA

[4] Examining the time period for which there is data, not more than one 30-day average value shall exceed the criterion per three years of data.
[5] Salmonids are a type of fish that include chinook salmon, coho salmon, steelhead trout and coastal cutthroat trout.

recommended criteria is approximately 0.12 mg N/L for the salmonids present, acute condition. This difference occurs at 5 degrees Celsius and a pH value of 7.5 (See Table 1a).

For the salmonids absent, acute criteria, the 1999 U.S. EPA recommended ammonia criteria are higher (less stringent) at all temperature and pH values than the current Basin Plan criteria (See Figure 2). The maximum difference between the current Basin Plan and U.S. EPA recommended criteria is approximately 32 mg N/L. This difference occurs at 30 degrees Celsius and a pH of 6.5. The minimum difference between the current Basin Plan objectives and U.S. EPA recommended criteria is approximately 0.49 mg N/L for the salmonids absent, acute condition. This difference occurs at 25 degrees Celsius and a pH value of 9 (See Table 1a).

The differences between the current Basin Plan objectives and the U.S. EPA recommended criteria are greatest where the pH is equal to or less than 7.5. On average, the U.S. EPA recommended acute criteria are 1.56 times greater than the current Basin Plan objectives for ammonia (See Table 1b). [6]

Table 1a: Range of Differences between the Current Acute Basin Plan Objectives and the U.S. EPA Recommended Acute Criteria

ACUTE CRITERIA TYPE	mg N/L (pH range < or = 7.5)	mg N/L (pH range > 7.5)
Salmonids present, Acute	0.12 – 20.85	0.14 – 2.74
Salmonids absent, Acute	5.59 – 32.39	0.49 – 7.25
Min / Max	**0.12 – 32.39**	**0.14 – 7.25**

Table 1b: Ratio Between 1999 U.S. EPA Recommended Acute Criteria and Current Acute Basin Plan Objectives

ACUTE CRITERIA TYPE	mg N/L
Salmonids present, Acute	1.35
Salmonids absent, Acute	1.77
Average	**1.56**

[6] The 1999 EPA recommended acute criterion for the salmonids absent condition was divided by the Basin Plan acute objectives for warm waters for each pH and temperature scenario described in Table 3-2 of the Basin Plan. The average of these ratios was then calculated. The same calculation was conducted for the salmonids present condition. The average of these ratios was then calculated. Finally the average was taken of the two calculated averages to derive the summary ratio given above for the difference between the acute objectives under the Basin Plan and the 1999 recommended criteria.

Figure 1

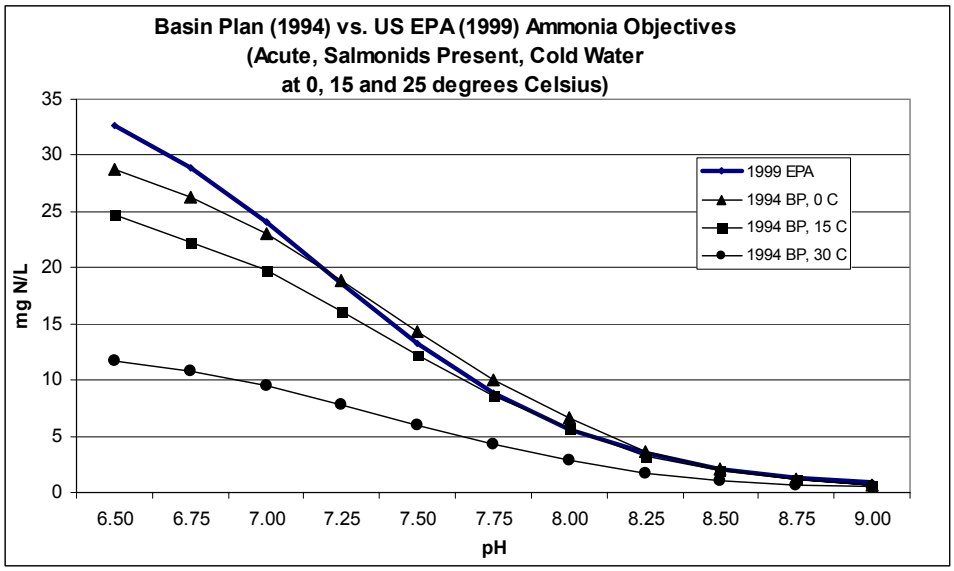
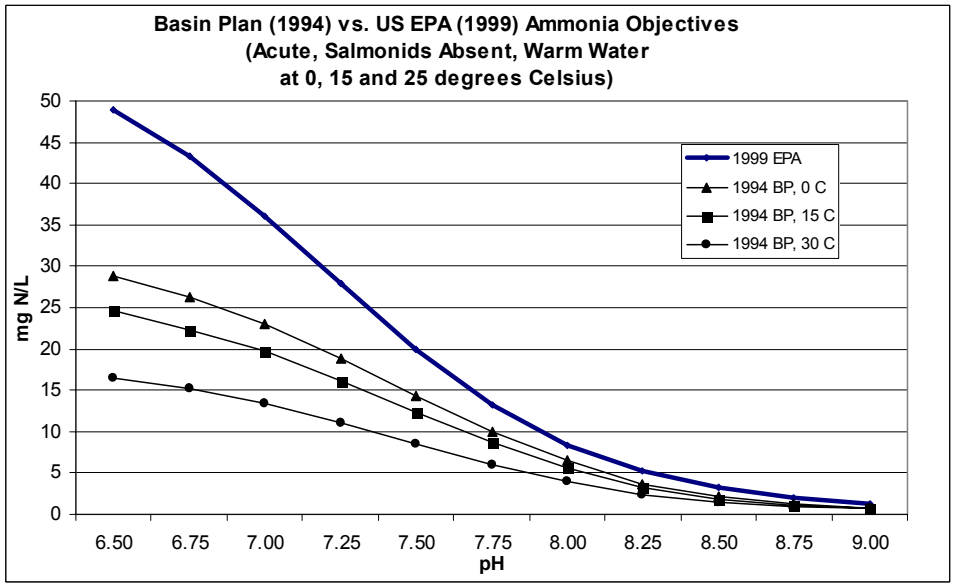


Figure 2



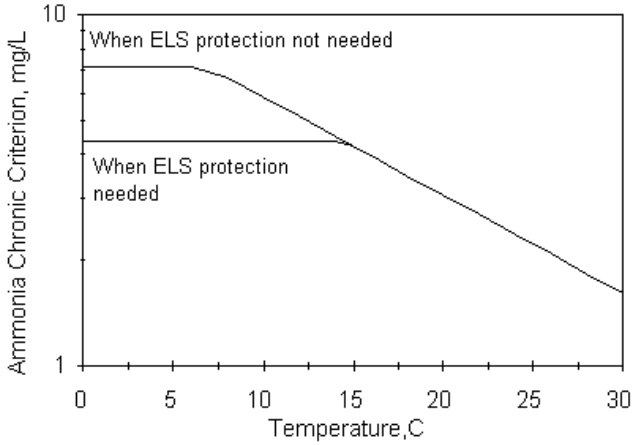
Criteria Continuous Concentration (chronic criteria)

The CCC (criteria continuous concentration) is a function of pH, temperature and presence/absence of "early life stages" (ELS) of fish. The 1999 CCC criteria are based on a revised relationship to temperature. Above 15 degrees Celsius, invertebrates are the most sensitive chronic test species. The higher the temperature or pH the less ammonia invertebrates can tolerate. At low temperatures (below 15 degrees Celsius), the CCC depends instead on whether early life stages of fish are present. At temperatures below 15 degrees Celsius, where ELS are present, the chronic criterion for ammonia is 4.36 mg/L as nitrogen (mg N/L). However, ELS have the same sensitivity to ammonia irrespective of how low the temperature is below 15 degrees Celsius, therefore

the curve flattens beginning at 15 degrees Celsius in Figure 3. At temperatures below approximately 7 degrees Celsius, when ELS are not present, fish are more sensitive to ammonia than are invertebrates. Again, fish sensitivity to ammonia does not depend on temperature changes below 7 degrees Celsius, so the curve flattens out where the ammonia criterion is 7.09 mg N/L.

The CCC is not species specific but is based on the most sensitive test species. In addition, the criteria include a sub-chronic (4-day) criteria which is higher than the 30-day chronic criteria. Specifically the sub-chronic (4-day) is 2.5 times higher than the chronic (30-day) criteria. Prior to the 1999 Update, the factor was 2.0.

Figure 3. Chronic criterion values in the 1999 Update; pH=7.5.



As can be seen in Figures 4 through 11, the 1999 Update contains chronic criteria for ammonia that are higher (less stringent) in all cases than the criteria (objectives)[7] currently in the Basin Plan. The greatest differences between the present and recommended criteria are at low pH values (equal to or less than 7.5), where the maximum difference is about 22 mg N/L. This difference occurs in warm waters where ELS are absent. At pH values greater than 7.5, the maximum difference is about 11 mg N/L. This difference also occurs for warm-water habitat where ELS is absent. See Table 2a below for the range of differences between U.S. EPA criteria and Basin Plan objectives for each chronic criteria type at various pH levels. On average, the U.S. EPA recommended criterion is 6.35 times greater than the current Basin Plan objective for ammonia (See Table 2b).[8]

[7] The allowable limits or levels of water quality constituents or characteristics, which are established for the reasonable protection of beneficial uses of water or the prevention of a nuisance within a specific area are referred to as “criteria” in the federal Clean Water Act. By contrast these limits or levels are called “objectives” in the State of California Porter-Cologne Water Quality Control Act.

[8] The 1999 EPA recommended chronic criterion for the warm water/ELS present condition was divided by the Basin Plan chronic objective for warm waters for each pH and temperature scenario. The average of these ratios was then calculated. This calculation was repeated for three other scenarios: warm water/ELS absent, cold water/ELS present and cold water/ELS absent. Finally, the average was taken of all of the calculated averages to derive the summary ratio given above.

Table 2a: Range of Differences between the Current Chronic Basin Plan Objectives and 1999 U.S. EPA Recommended Chronic Criteria

CHRONIC CRITERIA TYPE	mg N/L (pH range < or = 7.5)	mg N/L (pH range > 7.5)
Cold, ELS Absent	3.29-24.76	0.37-11.58
Cold, ELS Present	3.29-14.45	0.37-6.39
Warm, ELS Absent	2.99-24.76	0.34-11.58
Warm, ELS Present	2.99-14.45	0.34-6.39
Min / Max	**2.99 - 24.76**	**0.34 – 11.58**

Table 2b: Ratio Between 1999 U.S. EPA Recommended Chronic Criteria and Current Chronic Basin Plan Objectives

CHRONIC CRITERIA TYPE	mg N/L
Cold, ELS Absent	7.4
Cold, ELS Present	6.08
Warm, ELS Absent	6.62
Warm, ELS Present	5.3
Average	**6.35**

Criteria Continuous Concentration – Early Life Stage Provision

U.S. EPA has established a provision in its ammonia criteria that allows for a relaxation of the CCC when early life stages (ELS) of fish are not present, since, at low ambient water temperatures, adult and juvenile fish are less sensitive to ammonia toxicity than are ELS fish. U.S. EPA has concluded that it would be appropriate to relax the ammonia CCC, as ambient water temperature decreases, in water bodies at certain times of the year where early life stages are not present. The magnitude of the ELS-absent adjustment is dependent on temperature. There are two tables in the 1999 Update, one for periods when early life stages are present and one when absent (see Appendix 2).

The early life stages include the pre-hatch embryonic period, the post-hatch free embryo or yolk-sac fry, and the larval period, during which the organism feeds. The ELS does not include the juvenile stage. The duration of ELS lasts from the beginning of spawning until the end of the ELS. The end of ELS varies per fish species. The duration of ELS of selected fish can be seen in Table 3 below.

Table 3: Duration of ELS for Selected Species

TAXON	End of ELS Development (in days after spawning)
Fathead minnow	34 days
Channel catfish	34 days
Bluegill	34 days
White sucker	34 days
Northern pike	34 days
Striped bass	46 days
Trout, salmon, char	30 days after swim-up (swim-up is the stage when fry leave the nest and swim up to the surface to catch food.

Chronic Criteria (ELS Absent, Cold Water)

Figure 4

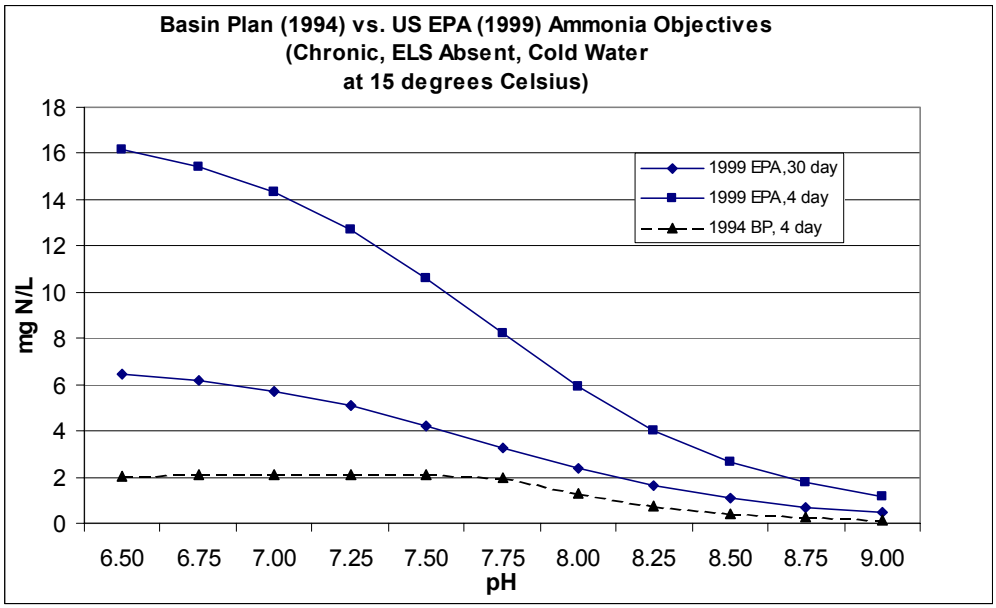
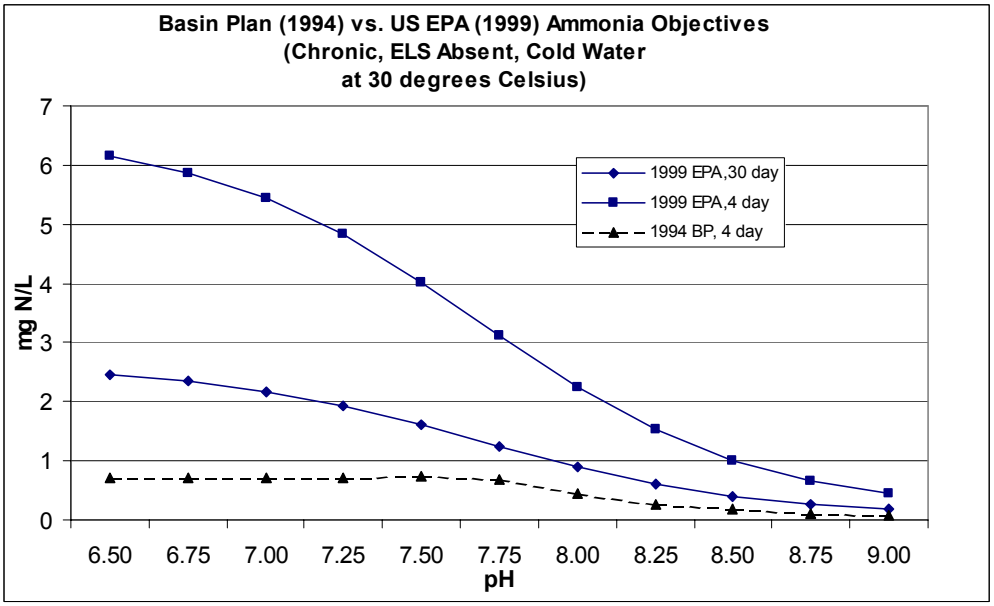


Figure 5



Chronic Criteria (ELS Present, Cold Water)

Figure 6

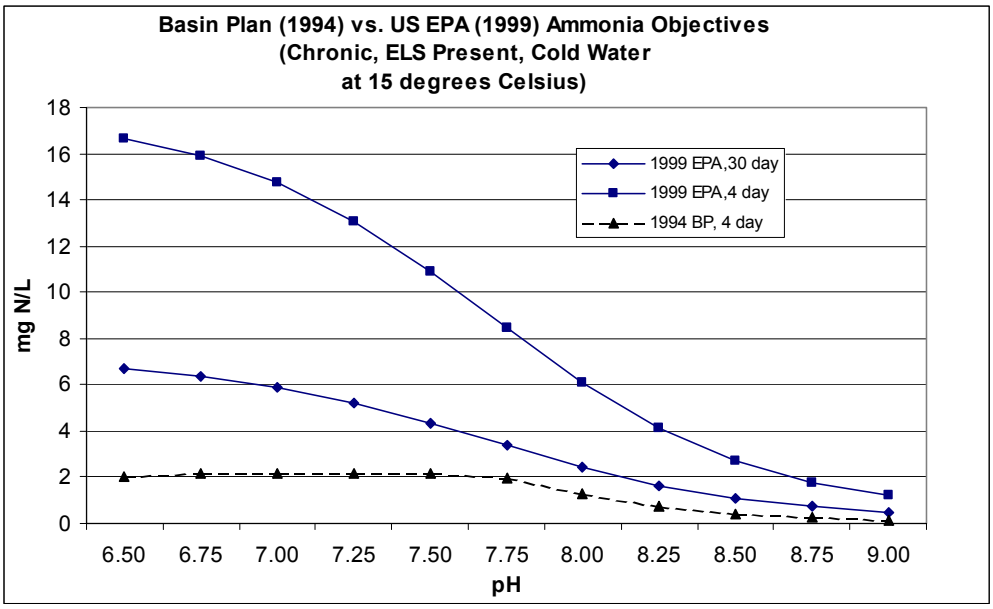
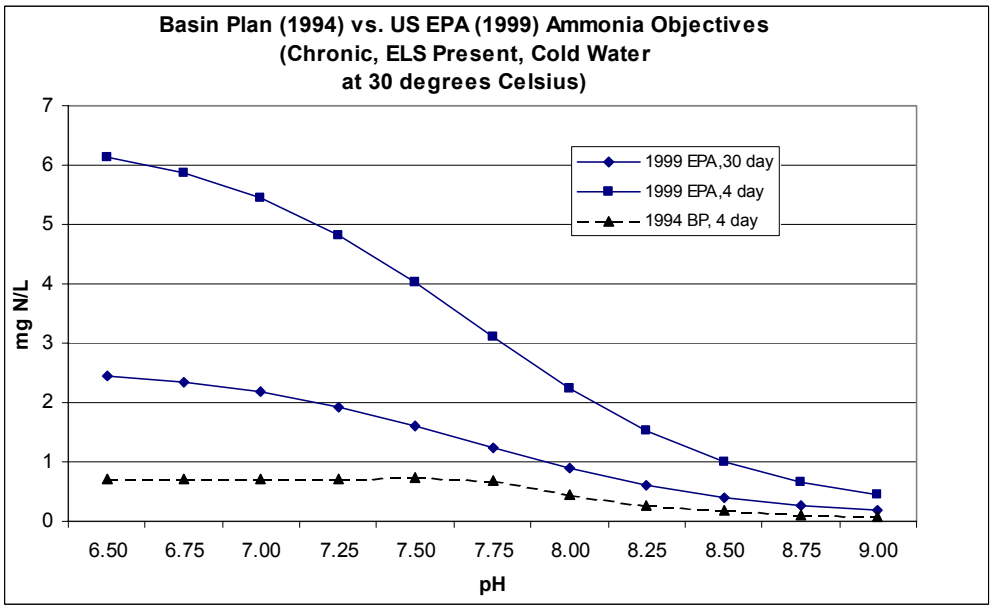


Figure 7



Chronic Criteria (ELS Absent, Warm Water)

Figure 8

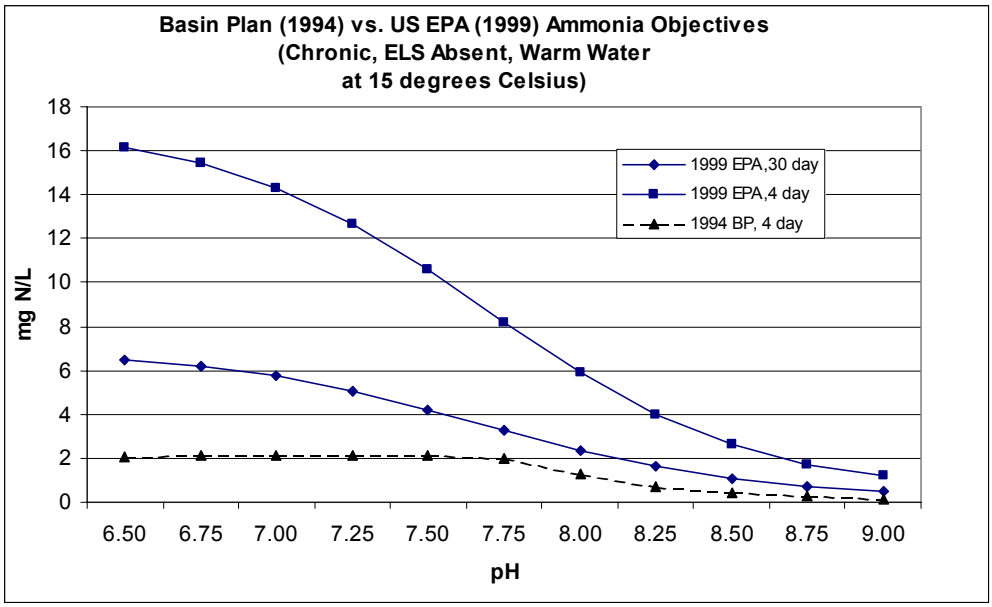
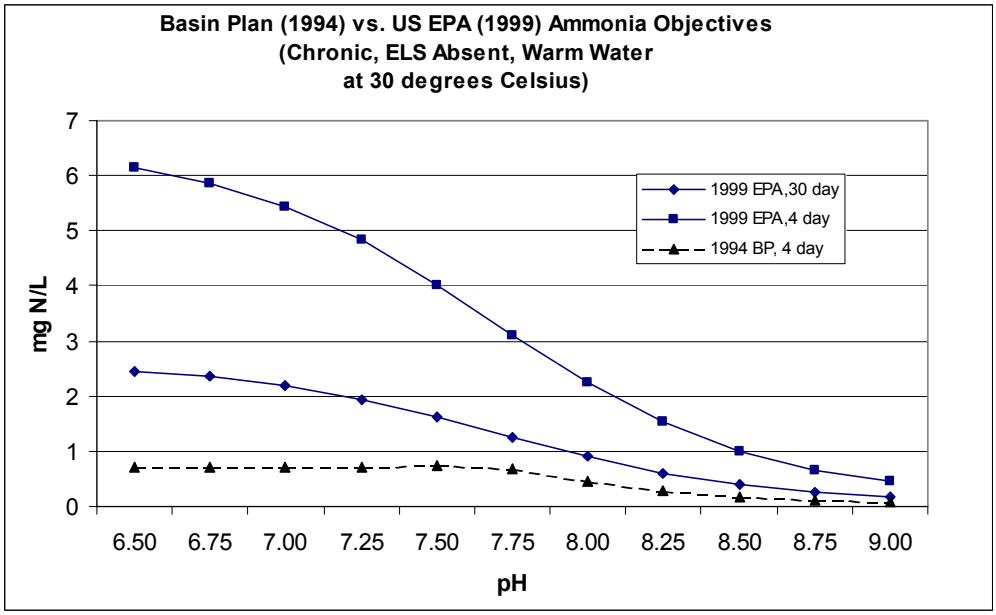


Figure 9



Chronic Criteria (ELS Present, Warm Water)

Figure 10

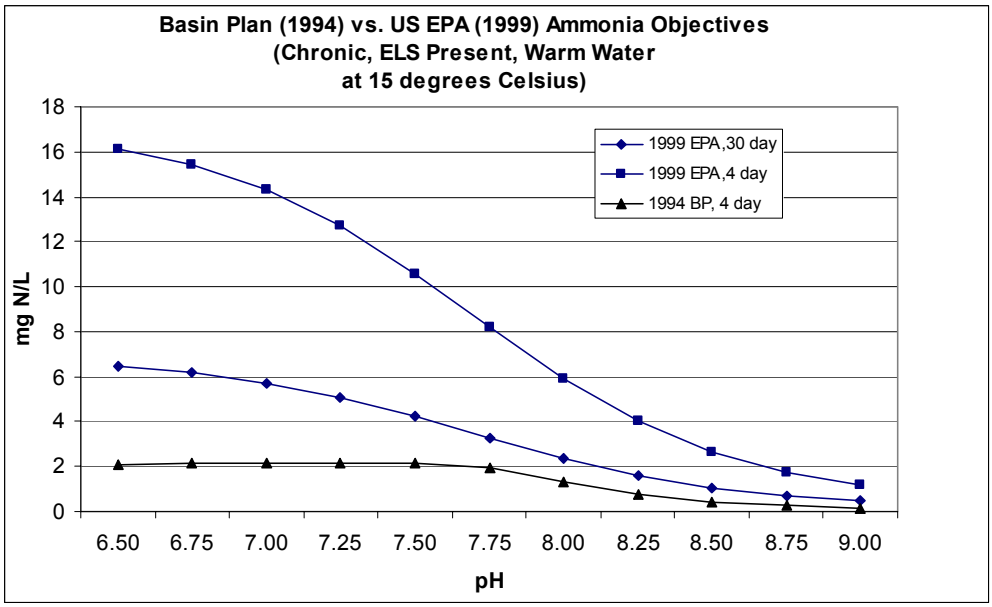
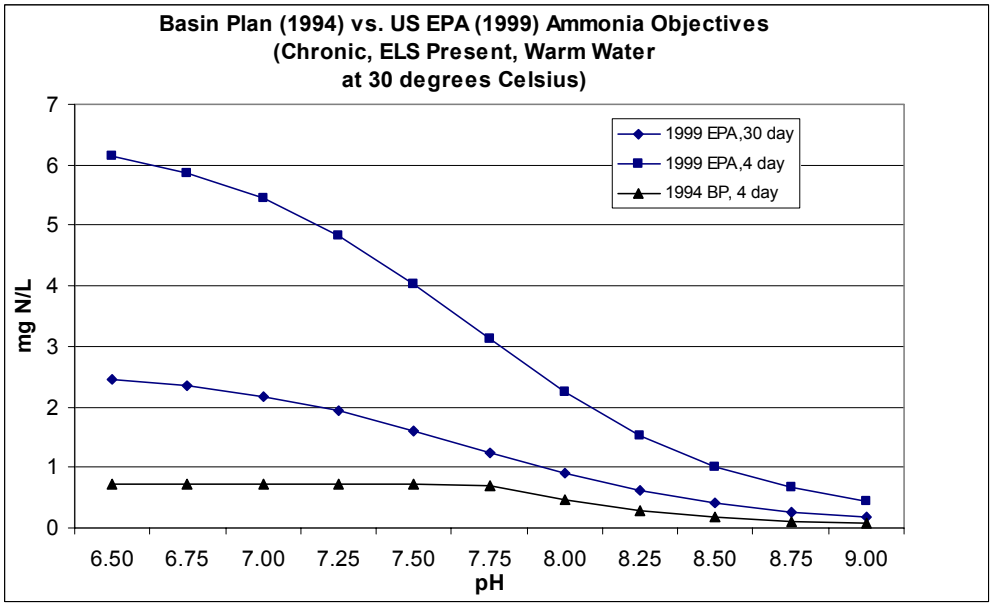


Figure 11



IV. IMPLEMENTATION OF AMMONIA OBJECTIVES

Application of Ammonia Objectives to Inland Surface Waters in the Los Angeles Region

Compliance with Proposed Objectives
The current Basin Plan provides up to eight years following the adoption of the 1994 Basin Plan by the Regional Board (or until June 13, 2002) to achieve compliance with the current ammonia objectives. Since the proposed Basin Plan amendment will become effective after the existing June 13, 2002 deadline, and the proposed objectives are less stringent than the current objectives, a compliance schedule for the revised objectives is unnecessary. As a result, the proposed amendment strikes the current compliance schedule language and will become effective immediately upon approval by U.S. EPA.

Acute Objective – Warm vs. Cold
To implement the acute objectives it is necessary to determine whether salmonids are present or absent to determine which of the objectives applies. In the absence of this information, the designated beneficial use "COLD" specifies an environment at which temperatures are appropriate for various life stages of salmonids. Conversely, the designated beneficial use "WARM" specifies an environment that salmonids could survive in during certain life stages but not during all of their life stages. In light of the beneficial use designations and in the absence of additional information to the contrary, it will be assumed that salmonids may be present in waters designated in the Basin Plan as "COLD."

Chronic Objectives – ELS Provision
It is necessary to determine the time of the year when ELS are not present in numbers that, if chronic toxicity did occur, would affect the long-term success of the fish population. It will be assumed that all fresh water bodies in the Los Angeles Region support ELS. A site-specific study will be needed in order to invoke the ELS absent provision. Water bodies with a Basin Plan designation of existing for "SPWN" support high quality aquatic habitats suitable for reproduction and early development of fish and therefore will be designated as ELS present waters, regardless of whether a site-specific study is conducted.

To conduct a site-specific study as to whether and when the ELS-absent provision should be applied, all readily available information regarding the fish species distributions, spawning periods, nursery periods and the duration of sensitive life stages should be considered for that water body. Information on water body temperature may also be useful. Expert opinions from fisheries biologists and other scientists should be relied upon. To determine when the ELS absent provision should go into effect, States or Tribes can rely on the same date every year (based on average annual ambient temperatures) or rely on water temperature thresholds. It is simpler to rely on start and end dates based on past temperature data. The record of information to determine the ELS absent condition must hold up to public and U.S. EPA's scrutiny.

Applicable Temperature and pH Ranges
Not all pH and temperature ranges in Figures 1-11 are applicable to inland surface water conditions in the Los Angeles Region. For example, looking at water quality data used to conduct a regional water quality assessment per section 305(b) of the CWA, the

average pH in all water bodies is 8.03, with a standard deviation of 0.39. This means that 68% of all pH data falls between 7.64 and 8.42 and that 95% of all data falls between 7.25 and 8.80. Only portions of the curves graphed in Figures 1-11 are relevant to the majority of pH conditions exhibited in water bodies in the Los Angeles Region. The portion of the curve that is most relevant to the Los Angeles Region is where the differences between the existing and proposed objectives are moderate. Therefore, the maximum differences between the existing and proposed objectives on the left of these graphs are not applicable to the Los Angeles Region.

The average temperature in all water bodies is 19.14 degrees Celsius, with a standard deviation of 4.11 degrees Celsius. This means that 68% of all temperature data falls between 15.03 and 23.24 degrees Celsius and 95% of all data falls between 10.92 and 27.35 degrees Celsius. Therefore both the 15 and 30 degree Celsius figures among Figures 1-11 are important to look at, as in Los Angeles, the water bodies fall within both of these categories.

Existence of Threatened or Endangered Species

States are required to protect all beneficial uses, and therefore should protect for the most sensitive uses in a given water. Because ambient criteria are generally designed to protect 95% of all fish and aquatic invertebrate taxa, there remains a small possibility that the criteria will not protect all listed or threatened species. Where endangered or threatened species may be more sensitive to a pollutant than the species upon which the criteria are based, more stringent, site-specific modifications of the criteria shall be necessary. Adjustments can be made by one of two methods.[9]

Translation of Objectives into Effluent Limits

The use of aquatic life criteria for developing water quality-based permit limits and for designing waste treatment facilities requires the selection of an appropriate waste load allocation model. U.S. EPA recommends that for ammonia, the waste load allocation be based on a critical condition defined as follows:

For the CMC, the U.S. EPA recommends the use of:

1. the lowest one-day flow based on a three-year return interval (1B3) when flow records are analyzed using U.S. EPA's 1986 DFLOW procedure.[10]
2. the lowest one-day flow based on a ten-year return interval (1Q10) when flow records are analyzed using extreme-value statistics.[11]

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[9] 1) If the CMC is greater than 0.5 times the Species Mean Acute Value (SMAC) for a threatened or endangered species, or a surrogate for such species, then the CMC should be reset to 0.5 times the SMAC. If the CCC is greater than the Species Mean Chronic Value (SMCV) of a threatened or endangered species, or surrogate, then the CCC should be reset to that SMCV. If the SMCV is not available, then the CCC can be reset by dividing the SMAC by the Acute to Chronic Ration (ACR) in accord with EPA's "Guidance for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and their Uses" (1985).

2) More stringent, site-specific modifications may be calculated to protect a listed endangered of threatened species by using the recalculation procedure described in Chapter 3 of the "U.S. EPA Water Quality Standards Handbook, Second Edition – Revised" (1994).

[10] A U.S. EPA procedure that treats flow in each successive day as a separate event.

3. Other appropriate critical flow condition.

For the CCC, the U.S. EPA recommends the use of:
1. the lowest 30-day flow based on a three-year return interval (30B3) when flow records are analyzed using U.S. EPA's 1986 DFLOW procedure or
2. the 30Q10 or the 30Q5 (lowest 30-day flow based on a ten or five-year return interval) when flow records are analyzed using extreme-value statistics.
3. Other appropriate critical flow condition.

In addition, within the 30-day averaging period, no 4-day average concentration should exceed 2.5 times the CCC. Waste Load Allocations based on a critical condition of 30Q10 are protective of both the 30-day average and the 4-day average. If a 30Q5 is used, the State must demonstrate that the 7Q10 (seven-day low flow which recurs once every ten years on the average) is protective of 2.5 times the CCC, to ensure that short-term (4-day) chronic toxicity does not occur. The more stringent (i.e. lower) of the 30Q5 or the 7Q10 should be used.

Procedures outlined in the "Technical Support Document for Water-Quality-Based Toxics Control" (TSD) should be adjusted when implementing the ammonia objective to accommodate the 30-day averaging period to calculate an NPDES permit limit. The TSD is designed to address a 4-day averaging period.

The equation to determine the chronic long-term average concentration (LTA_{c30}) should be modified as follows to address the 30-day averaging period:

$$(LTA_{c30}) = WLA_{c30}\, e^{[0.5\sigma_{30}^2 - z\sigma_{30}]}$$

where:

$$\sigma_{30}^2 = \ln(CV^2/30 + 1)$$

WLA = waste load allocation; CV = coefficient of variance

The acute Long Term Average (LTA_a) and 4-day (sub-chronic) Long-Term Average (LTA_{c4}) should be performed using the equations in the TSD and the maximum daily limit (MDL) and average monthly limit (AML) are calculated from the $LTA_{min.}$ The value of "n" (assumed monitoring frequency) used in the AML calculation should not be less than the averaging period upon which the criterion value is based.

V. OTHER CONSIDERATIONS

The California Water Code (CWC), section 13241, specifies that Regional Boards shall establish water quality objectives that in its judgement will ensure the reasonable protection of beneficial uses and the prevention of nuisances. Factors to be considered

[11] A U.S.G.S. procedure that counts only one value per year, the lowest daily flow in that year, and therefore does not consider the duration (in days) of such low flows may occur in each year.

by a Regional Board when establishing water quality objectives shall include, but not necessarily be limited to all of the following:

1. Past, present and probable future beneficial uses of water
2. Environmental characteristics of the hydrographic unit under consideration including the quality of the water available thereto.
3. Water quality conditions that could reasonably be achieved through coordinated control of all factors, which affect water quality in the area.

   The "Beneficial Uses" and "Water Quality Objectives" chapters of the Basin Plan (Water Quality Control Plan for the Los Angeles Region) are incorporated by reference to address the above three factors.

4. Economic considerations.

   This Basin Plan Amendment will result in ammonia objectives that will be less stringent than the existing objectives in most cases. Therefore the economic burden on the regulated community will be less than the burden resulting from the existing objectives.

5. The need for developing housing within the region.

   These criteria should not affect the housing market, as the criteria are less stringent than those that they replace.

6. The need to develop and use recycled water.

   Increasing the levels of ammonia should not alter the development or use of recycled water because this amendment only applies to surface water discharges.

V. ALTERNATIVES

1. **No action**. To maintain the existing objectives would be to ignore the latest, peer-reviewed scientific data.
2. **Adopt U.S. EPA recommended criteria and associated implementation provisions**. By adopting the proposed revisions to the ammonia objectives for fresh water, the Regional Board will make the region's ammonia objectives consistent with U.S. EPA guidance, which is based on the latest research. Finally, by acting proactively, we will be able to more efficiently carry out other activities such as developing the region's 303(d) list, developing TMDLs, and specifying effluent limits in discharge permits.
3. **Adopt U.S. EPA recommended criteria and associated implementation provisions with modifications arising as a logical outgrowth of the proposed amendment.** The Regional Board staff hereby solicits comments on possible alternative criteria that may be used for the ammonia water quality objective for inland surface waters.

VI. RECOMMENDED ALTERNATIVE

Staff recommends adopting 1999 U.S. EPA recommended criteria for ammonia and associated implementation provisions.

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Glossary

AML	Average monthly limit
Ammonia	NH_3, un-ionized ammonia, more toxic than ammonium (NH_4^+)
Ammonium	NH_4^+, ionized ammonia, less toxic than ammonia (NH_3)
CCC	Criteria continuous concentration
CMC	Criteria maximum concentration
ELS	Early Life Stages
Extreme-value Statistics	U.S.G.S. procedure that is commonly used and counts only one value per year, the lowest daily flow in that year, and therefore does not consider the duration (in days) of such low flows may occur in each year
LOEC	Lowest observed effect level
LTA	Long term average
MDL	Maximum daily limit
NOEC	No observed effect level
Salmonids	Salmonids include chinook salmon, coho salmon, steelhead trout and coastal cutthroat trout
1986 DFLOW Procedure	A U.S. EPA procedure that is infrequently used and treats flow in each successive day as a separate event
TSD	Technical Support Document for Water-Quality-Based Toxics Control

APPENDIX 1

(NOT INCLUDED IN WEB VERSION)

APPENDIX 2

Table 1. 1999 Acute Criteria: Selected Values for One-hour Average Concentration for Ammonia

CMC, mg N/L		
pH	**Salmonids Present**	**Salmonids Absent**
6.5	32.60	48.80
6.6	31.30	46.80
6.7	29.80	44.60
6.8	28.10	42.00
6.9	26.20	39.10
7.0	24.10	36.10
7.1	22.00	32.80
7.2	19.70	29.50
7.3	17.50	26.20
7.4	15.40	23.00
7.5	13.30	19.90
7.6	11.40	17.00
7.7	9.65	14.40
7.8	8.11	12.10
7.9	6.77	10.10
8.0	5.62	8.40
8.1	4.64	6.95
8.2	3.83	5.72
8.3	3.15	4.71
8.4	2.59	3.88
8.5	2.14	3.20
8.6	1.77	2.65
8.7	1.47	2.20
8.8	1.23	1.84
8.9	1.04	1.56
9.0	0.885	1.32

APPENDIX 2 (Continued)

Table 2. Chronic Criteria (ELS Present): Selected Values for 30-day Average Concentration for Ammonia

CCC for Fish Early Life Stages Present, mg N/L										
	Temperature, C									
PH	0	14	16	18	20	22	24	26	28	30
6.5	6.67	6.67	6.06	5.33	4.68	4.12	3.62	3.18	2.80	2.46
6.6	6.57	6.57	5.97	5.25	4.61	4.05	3.56	3.13	2.75	2.42
6.7	6.44	6.44	5.86	5.15	4.52	3.98	3.50	3.07	2.70	2.37
6.8	6.29	6.29	5.72	5.03	4.42	3.89	3.42	3.00	2.64	2.32
6.9	6.12	6.12	5.56	4.89	4.30	3.78	3.32	2.92	2.57	2.25
7.0	5.91	5.91	5.37	4.72	4.15	3.65	3.21	2.82	2.48	2.18
7.1	5.67	5.67	5.15	4.53	3.98	3.50	3.08	2.70	2.38	2.09
7.2	5.39	5.39	4.90	4.31	3.78	3.33	2.92	2.57	2.26	1.99
7.3	5.08	5.08	4.61	4.06	3.57	3.13	2.76	2.42	2.13	1.87
7.4	4.73	4.73	4.30	3.78	3.32	2.92	2.57	2.26	1.98	1.74
7.5	4.36	4.36	3.97	3.49	3.06	2.69	2.37	2.08	1.83	1.61
7.6	3.98	3.98	3.61	3.18	2.79	2.45	2.16	1.90	1.67	1.47
7.7	3.58	3.58	3.25	2.86	2.51	2.21	1.94	1.71	1.50	1.32
7.8	3.18	3.18	2.89	2.54	2.23	1.96	1.73	1.52	1.33	1.17
7.9	2.80	2.80	2.54	2.24	1.96	1.73	1.52	1.33	1.17	1.03
8.0	2.43	2.43	2.21	1.94	1.71	1.50	1.32	1.16	1.02	0.897
8.1	2.10	2.10	1.91	1.68	1.47	1.29	1.14	1.00	0.879	0.773
8.2	1.79	1.79	1.63	1.43	1.26	1.11	0.973	0.855	0.752	0.661
8.3	1.52	1.52	1.39	1.22	1.07	0.941	0.827	0.727	0.639	0.562
8.4	1.29	1.29	1.17	1.03	0.906	0.796	0.700	0.615	0.541	0.475
8.5	1.09	1.09	0.990	0.870	0.765	0.672	0.591	0.520	0.457	0.401
8.6	0.920	0.920	0.836	0.735	0.646	0.568	0.499	0.439	0.386	0.339
8.7	0.778	0.778	0.707	0.622	0.547	0.480	0.422	0.371	0.326	0.287
8.8	0.661	0.661	0.601	0.528	0.464	0.408	0.359	0.315	0.277	0.244
8.9	0.565	0.565	0.513	0.451	0.397	0.349	0.306	0.269	0.237	0.208
9.0	0.486	0.486	0.442	0.389	0.342	0.300	0.264	0.232	0.204	0.179

APPENDIX 2 (Continued)

Table 3. Chronic Criteria (ELS Absent): Selected Values for 30-day Average Concentration for Ammonia

CCC for Fish Early Life Stages Absent, mg N/L										
	Temperature, C									
PH	0-7	8	9	10	11	12	13	14	15*	16
6.5	10.8	10.1	9.51	8.92	8.36	7.84	7.35	6.89	6.46	6.06
6.6	10.7	9.99	9.37	8.79	8.24	7.72	7.24	6.79	6.36	5.97
6.7	10.5	9.81	9.20	8.62	8.08	7.58	7.11	6.66	6.25	5.86
6.8	10.2	9.58	8.98	8.42	7.90	7.40	6.94	6.51	6.10	5.72
6.9	9.93	9.31	8.73	8.19	7.68	7.20	6.75	6.33	5.93	5.56
7.0	9.60	9.00	8.43	7.91	7.41	6.95	6.52	6.11	5.73	5.37
7.1	9.20	8.63	8.09	7.58	7.11	6.67	6.25	5.86	5.49	5.15
7.2	8.75	8.20	7.69	7.21	6.76	6.34	5.94	5.57	5.22	4.90
7.3	8.24	7.73	7.25	6.79	6.37	5.97	5.60	5.25	4.92	4.61
7.4	7.69	7.21	6.76	6.33	5.94	5.57	5.22	4.89	4.59	4.30
7.5	7.09	6.64	6.23	5.84	5.48	5.13	4.81	4.51	4.23	3.97
7.6	6.46	6.05	5.67	5.32	4.99	4.68	4.38	4.11	3.85	3.61
7.7	5.81	5.45	5.11	4.79	4.49	4.21	3.95	3.70	3.47	3.25
7.8	5.17	4.84	4.54	4.26	3.99	3.74	3.51	3.29	3.09	2.89
7.9	4.54	4.26	3.99	3.74	3.51	3.29	3.09	2.89	2.71	2.54
8.0	3.95	3.70	3.47	3.26	3.05	2.86	2.68	2.52	2.36	2.21
8.1	3.41	3.19	2.99	2.81	2.63	2.47	2.31	2.17	2.03	1.91
8.2	2.91	2.73	2.56	2.40	2.25	2.11	1.98	1.85	1.74	1.63
8.3	2.47	2.32	2.18	2.04	1.91	1.79	1.68	1.58	1.48	1.39
8.4	2.09	1.96	1.84	1.73	1.62	1.52	1.42	1.33	1.25	1.17
8.5	1.77	1.66	1.55	1.46	1.37	1.28	1.20	1.13	1.06	0.990
8.6	1.49	1.40	1.31	1.23	1.15	1.08	1.01	0.951	0.892	0.836
8.7	1.26	1.18	1.11	1.04	0.976	0.915	0.858	0.805	0.754	0.707
8.8	1.07	1.01	0.944	0.885	0.829	0.778	0.729	0.684	0.641	0.601
8.9	0.917	0.86	0.806	0.756	0.709	0.664	0.623	0.584	0.548	0.513
9.0	0.790	0.740	0.694	0.651	0.610	0.572	0.536	0.503	0.471	0.442